Demo: ROCH: Software-defined Radio Toolbox for Experimental Evaluation of All-spectrum Cognitive Networking

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ABSTRACT

We present the first complete software-based framework for real-time experimental evaluation of secondary multi-hop cognitive underlay networks with decentralized control. We build a 7-node software-defined radio testbed and implement a distributed algorithm that maximizes the secondary network throughput, while at the same time avoids interference to primary users through joint Routing and cOde-waveform CHannelization (ROCH). ROCH is implemented using GNU Radio and Universal Software Radio Peripherals (USRP − N210s). The implementation of ROCH is facilitated by the architectural abstractions of a novel radio framework, referred to as RcUBe, that provides reconfigurability at the PHY, MAC, and network layers of the protocol stack.

1. ROCH DEMONSTRATION

ROCH [1, 2, 3] is a novel decentralized cognitive channelization and routing algorithm that achieves throughput maximization in ad-hoc multi-hop secondary networks. The concept of cognitive channelization was firstly introduced in [1], while network-level system evaluation was performed in [2] through extensive simulation studies. The first software-defined radio testbed for joint code waveform and power allocation around narrowband and/or wideband primary stations was developed in [3]. The objective of this demonstration is to experimentally and in real-time evaluate the theoretical concepts of ROCH. The demonstration is facilitated by the reconfigurable radio architecture (RcUBe) proposed in [4], which provides a structured methodology at variable levels of abstraction to target cross-layer protocol implementations.

Figure 1 depicts the demo setup. We consider one active primary link (PTx–PRx), four secondary transceivers (i.e. source S and two relays R_1, R_2 one hop away from destination node D) and a trace recorder (TR). Both primary and secondary users are USRP − N210-hosted and interfaced with laptop-PCs via Gigabit Ethernet (GigE). Primary users coexist with secondary users by using a pre-assigned unique code and implementing a time-division duplex protocol. The implementation of ROCH in GNU Radio is facilitated by the RcUBe framework. Secondary users do not have any pre-assigned code waveform and implement a three-way handshake via exchange of Request-to-Send (RTS), Clear-to-Send (CTS) and Data Transmission reServation (DTS) packets, coded with a common code. The DTS packet is used to announce the information update on code, transmit power, and queueing to neighboring nodes. We consider that the secondary network has a fixed topology and each secondary node has a pre-defined neighbor table for routing purposes. On the other hand, the primary nodes locations can be changed during the demo execution time.

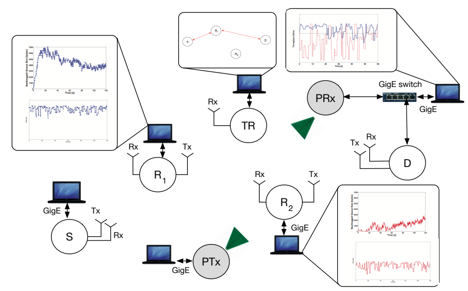

Figure 1: White-colored nodes: Secondary users with omnidirectional antennas. Gray-colored nodes: Primary users with log-periodic directional antennas.

The testbed capabilities are demonstrated through multiple graphical user interfaces (GUIs) at the relay, destination, and trace recorder nodes. Particularly, in each relay node we plot the instantaneous SINR and queueing information, while a GUI at the laptop-PC controlling the destination node and primary receiver (Fig. 1) depicts the instantaneous throughput of the secondary network and primary link. Finally, the trace recorder provides an illustration of the secondary routing connections.

2. REFERENCES

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SRIF'15, September 7, 2015, Paris, France.

 ISBN 978-1-4503-3532-4/15/09 ...$15.00.
DOI: http://dx.doi.org/10.1145/2801676.2801686.